3-30-2017

Creating and Managing Successful Groups

John Sangster
University of Nebraska - Lincoln, john.sangster@unl.edu

Creating and Managing Successful Groups

John Sangster, Ph.D., PE, PTOE
Assistant Professor, Department of Civil Engineering
University of Nebraska at Lincoln
March 30, 2017

Content for Today

- Why is group work an essential component of our classes?
- What are the standard practices in forming groups, and what are the outcomes from this practice?
- What does the research say about forming successful groups?
- Case Study: group work in senior-level road design course

Working in Groups as Civil Engineers Scholarship Imitating Life

- The Accreditation Board for Engineering and Technology (ABET) sets required skills for engineering graduates, commonly referred to as "*a-through-k*"

Working in Groups as Civil Engineers Scholarship Imitating Life

- Some parts of ABET "*a-through-k*" are straight-forward:
  - (a) an ability to apply knowledge of mathematics, science, and engineering
  - (b) an ability to design and conduct experiments, as well as to analyze and interpret data
  - (c) an ability to design a system, component, or process to meet desired needs with realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
  - (e) an ability to identify, formulate, and solve engineering problems
  - (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Working in Groups as Civil Engineers Scholarship Imitating Life

- Other parts of ABET "*a-through-k*" are harder to implement in a classroom environment:
  - (d) an ability to function on multidisciplinary teams
  - (f) an understanding of professional and ethical responsibility
  - (g) an ability to communicate effectively
  - (h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and social context
  - (i) a recognition of the need for, and ability to engage in life-long learning
  - (j) a knowledge of contemporary issues

Group Formation Standard Practice

- Most group projects start in a familiar way:
  - Step 1: Students form their own groups
  - Step 2: Remaining students are assigned groups at random

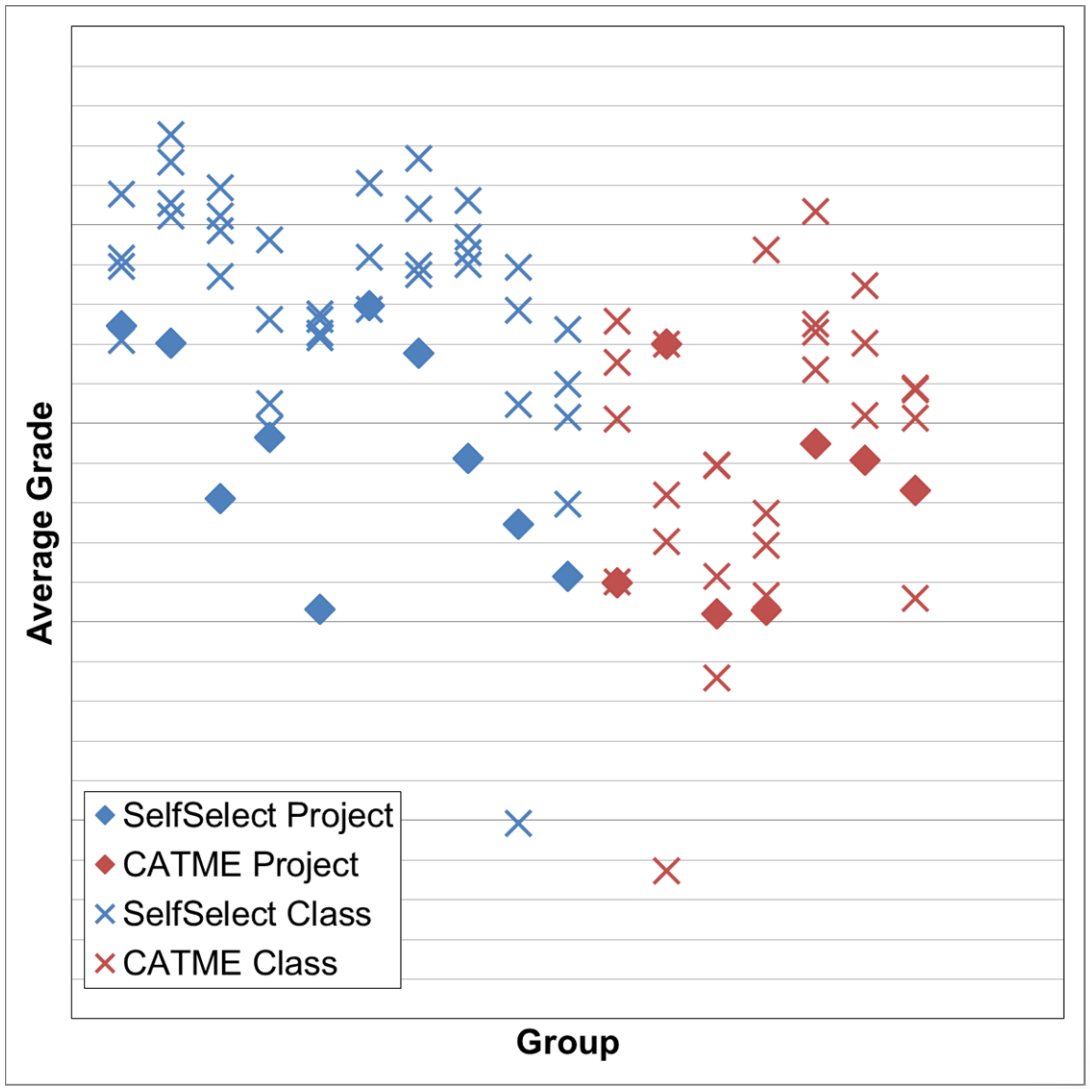
Typical Group Process

- The process for completing the work also follows a familiar pattern:
  - Step 1: One person takes leadership of the group, and splits the work into equal parts.
  - Step 2: The day before it's due, everyone sends back what they've done on their part.
  - Step 3: The person in charge sees that the work done by their peers is unusable, and completes the project by themselves.

Typical Group Results

- From the department's perspective:
  - A satisfactory project is submitted
  - Everyone in the course receives good marks
  - The department can demonstrate to ABET that the goals are being met
- From the student's perspective
  - Student resentment due to unequal efforts
  - Only some of the students have achieved the learning outcomes

Typical Group Results From Teaching Assistant Experience



Literature on Group Work Engineering-Specific Resource

- Johri, Aditya, and Barbara M. Olds, eds. *Cambridge Handbook of Engineering Education Research*. Cambridge University Press, 2014.
  - Chapters of interest on this topic include:
    - 8: Problem-based and Project-based Learning…
    - 10: Curriculum Design in the Middle Years
    - 20: Research-guided Teaching Practices…
    - 24: Studying Teaching and Learning in Undergraduate Engineering Programs…
    - 29: The Science and Design of Assessment…

Literature on Group Work Selected Reading

- Prince, Michael. "Does Active Learning Work? A Review of the Research." *Journal of Engineering Education* 93.3 (2004): 223-231.

- Barron, Brigid. "When Smart Groups Fail." *The Journal of the Learning Sciences.* 12.3 (2003): 307-359.

- Newstetter, Wendy C. "Of Green Monkeys and Failed Affordances: A Case Study of a Mechanical Engineering Design Course." *Research in Engineering Design* 10.2 (1998): 118-128.

Case Study Context

- Speaker appointment is 30% teaching, with a load of one course per semester (for now)

- Courses taught thus far categorized as “design” technical electives
  - Senior/graduate overlap
  - Significant project components with groups arriving at unique solutions
  - Hands-on with standard software used in consulting

Case Study Context

- CIVE 462/862 – Highway Design
  - Five individual homework assignments
    - Median time spent per person (on all five): 21 hours
  - Six group project assignments
    - Median time spent per person (on first four): 22 hours

- CIVE 463/863 – Traffic Engineering
  - Eight individual homework assignments
    - Median time spent per person (on first five): 20 hours
  - One group project assignment
    - Median time spent: unknown

Case Study Context

- CIVE 462/862 – Highway Design Projects
  1. Identify problems around town (intersection, interchange, and roadway alignment)
  2. Redesign of interchange using planning-level analysis tools

Roadway Alignment Project

  3. Horizontal alignment
  4. Vertical alignment
  5. Cross-sections and limit of work
  6. 30% completion plan set

Case Study
Outcomes of Group Management

- By making informed decisions when creating groups, we can:
  - Maximize the percentage of successful groups

- By helping manage the time spent during the project we can:
  - Maximize the learning outcomes of each student in the class
  - Minimize the percentage of imploding groups
  - Calibrate both student efforts and project scopes

Case Study
Group Formation

- We hold these truths to be self-evident…
  that **not** all students are created equal!

- That all students have unique goals in the class
- That all students have unique time commitments outside of class
- That all students have unique background experience related to the topic

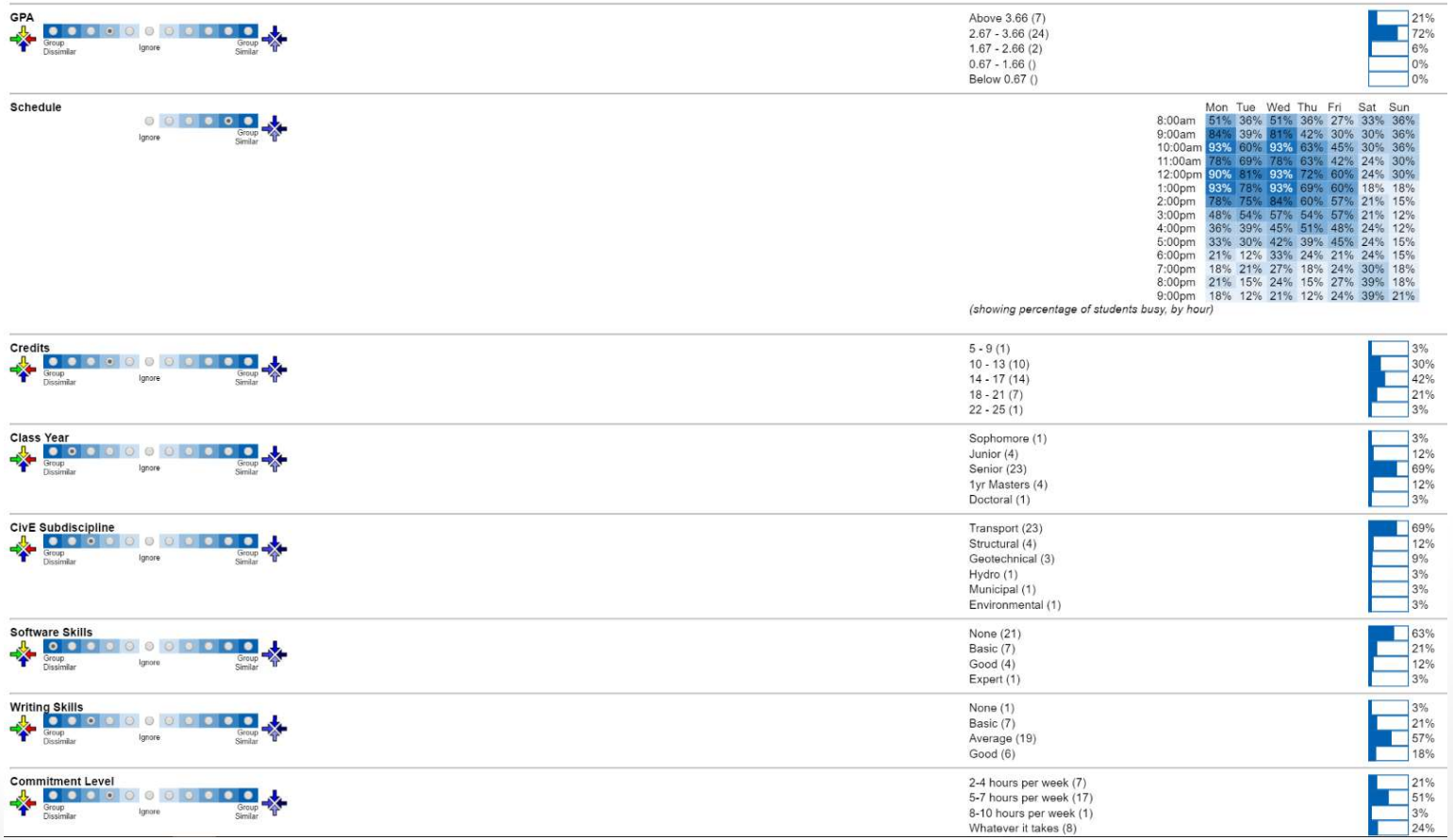
Case Study
Group Management Software

- Preferred group management software: www.catme.org
  - 28 parameters to choose from
  - Weighted as similar or disparate for group formation
  - Ability to pair or separate students/groups
  - Recently introduced a fee to use

CATME
SMARTER Teamwork

Case Study
Group Management Software

- Sub-set of 8 parameters chosen for Highway Design class



Case Study
Group Management Software

- Group formation can be re-run multiple times. Produces slightly different results each time and can be fine-tuned

GPA	Schedule	Pct Busy	Credits	Year	CivE Sub	Software	Writing	Commitment Lvl	Tot (Max 25)
3.5 (3)	5 days/week with 2+ hr meeting blocks (schedule summary)	50%	13 (1)	Senior	Transport	None	Basic	Whatever it takes	
3.77 (4)		38%	16 (3)	Senior	Transport	Basic	Average	5-7 hours per week	
2.98 (1)		20%	15 (2)	Senior	Transport	None	Average	5-7 hours per week	
2.743 (1)		32%	15 (2)	Junior	Structural	None	Average	2-4 hours per week	
1.00	**4.00**		**1.00**	**0.00**	**0.00**	**0.00**	**0.00**	**1.00**	**7.00**
3.0 (1)	3 days/week with 2+ hr meeting blocks (schedule summary)	38%	13 (1)	Senior	Transport	None	Average	5-7 hours per week	
3.4 (3)		55%	15 (2)	Senior	Geotechnical	None	Average	5-7 hours per week	
3.1 (2)		69%	17 (3)	Senior	Hydro	Basic	Basic	2-4 hours per week	
2.00	**0.80**		**2.00**	**-4.00**	**3.00**	**1.67**	**1.00**	**0.67**	**7.13**
3.0 (1)	5 days/week with 2+ hr meeting blocks (schedule summary)	50%	18 (5)	Senior	Geotechnical	None	Good	5-7 hours per week	
3.45 (3)		46%	18 (5)	1yr Masters	Transport	Basic	Average	8-10 hours per week	
2.88 (1)		38%	13 (1)	1yr Masters	Transport	None	Average	Whatever it takes	
3.1 (2)		38%	18 (5)	Senior	Municipal	None	Good	5-7 hours per week	
1.00	**4.00**		**0.00**	**0.00**	**1.50**	**0.00**	**0.00**	**1.00**	**7.50**
2.83 (1)	3 days/week with 2+ hr meeting blocks (schedule summary)	40%	10 (1)	1yr Masters	Transport	None	Basic	Whatever it takes	
3.62 (4)		41%	19 (5)	Senior	Geotechnical	None	Average	5-7 hours per week	
3.01 (2)		22%	15 (2)	Senior	Transport	Basic	Average	2-4 hours per week	
3.67 (4)		55%	16.67 (3)	Doctoral	Transport	None	Average	2-4 hours per week	
1.00	**1.87**		**2.00**	**2.00**	**0.00**	**0.00**	**0.00**	**1.00**	**7.87**
3.167 (2)	4 days/week with 2+ hr meeting blocks (schedule summary)	60%	14 (2)	Junior	Environmental	None	Average	5-7 hours per week	
3.9 (4)		14%	9 (1)	1yr Masters	Transport	None	Average	Whatever it takes	
3.2 (3)		50%	12 (1)	Senior	Transport	None	Good	5-7 hours per week	
3.7 (4)		40%	17 (3)	Senior	Transport	Good	Basic	5-7 hours per week	
1.00	**2.40**		**1.00**	**2.00**	**0.00**	**0.00**	**1.50**	**0.00**	**7.90**
4.0 (4)	3 days/week with 2+ hr meeting blocks (schedule summary)	31%	20 (5)	Senior	Structural	Basic	Average	5-7 hours per week	
3.50 (3)		42%	16 (3)	Senior	Transport	Good	Good	5-7 hours per week	
3.0 (1)		65%	16 (3)	Senior	Transport	None	None	Whatever it takes	
2.00	**0.80**		**0.67**	**-4.00**	**1.00**	**5.00**	**3.00**	**0.67**	**9.13**
2 (1)	5 days/week with 2+ hr meeting blocks (schedule summary)	25%	12 (1)	Junior	Transport	None	Average	5-7 hours per week	
3.2 (3)		35%	14 (2)	Senior	Transport	None	Basic	5-7 hours per week	
3.60 (4)		38%	16 (3)	Senior	Transport	Basic	Average	2-4 hours per week	
2.00	**4.00**		**2.00**	**1.33**	**-3.00**	**1.67**	**1.00**	**0.67**	**9.67**
2,6 (1)	6 days/week with 2+ hr meeting blocks (schedule summary)	24%	12 (1)	Sophomore	Structural	None	Basic	5-7 hours per week	
2.7 (1)		52%	10 (1)	Senior	Transport	Expert	Average	2-4 hours per week	
3.8 (4)		52%	12 (1)	Senior	Transport	Good	Average	5-7 hours per week	
3.1 (2)		61%	19 (5)	Senior	Transport	None	Good	Whatever it takes	
1.00	**4.00**		**0.00**	**0.00**	**0.00**	**2.50**	**1.50**	**1.00**	**10.00**
3.9 (4)	6 days/week with 2+ hr meeting blocks (schedule summary)	47%	21 (5)	Junior	Structural	Basic	Good	5-7 hours per week	
3.5 (3)		32%	23 (5)	Senior	Transport	Good	Average	2-4 hours per week	
3.0 (1)		32%	17 (3)	Senior	Transport	None	Average	Whatever it takes	
3.3 (3)		40%	13 (1)	Senior	Transport	None	Basic	Whatever it takes	
1.00	**4.00**		**1.00**	**0.00**	**0.00**	**2.50**	**1.50**	**1.00**	**11.00**

Case Study
Ongoing Group Management

- Setting groups up to be successful isn't the end of the story, it's the beginning

- Six one-week-long projects over the duration of the semester.
- The same groups throughout, with projects building on one another.

Case Study
Group Management - Time

CEE 4654 Geometric Design of Highways Spring '14

Pre-Project Estimating Worksheet - Group

Group Member 1: _____
Group Member 2: _____
Group Member 3: _____
Group Member 4: _____

Project No. #2

Group Estimated Workload for Project

Organizing	0.25 hrs leading	Training	0 hrs leading
	0.75 hrs supporting		0 hrs supporting
Site Visit	27 hrs leading	Drafting	4 hrs leading
	81 hrs supporting		4 hrs supporting
Write-up	4 hrs leading	QA / QC	1 hrs leading
	4 hrs supporting		0 hrs supporting

Total 36.25 hrs leading (9.25 without site visit) 89.75 hrs supporting (8.75 without site visit)

Draft Individual Workload Assignment for Project

Leading Hours (Hours working independently or leading cooperative work.)

Group Member	Organize	Train	Site Visit	Drafting	Write-up	QA / QC
1	0	0	0	0	0	0
2	0.25	0	0	4	0	1
3	0	0	0	0	2	0
4	0	0	27	0	2	0

Supporting Hours (Hours working cooperatively in a support role.)

Group Member	Organize	Train	Site Visit*	Drafting	Write-up	QA / QC
1	0.25	0	27	0	2	0
2	0	0	27	0	2	0
3	0.25	0	27	4	0	0
4	0.25	0	0	0	0	0

*Site Visit depends on time scheduling and availabity of funding.

CEE 4654 Geometric Design of Highways Spring '14

Post-Project Recording Worksheet - Group

Group Member 1: _____
Group Member 2: _____
Group Member 3: _____
Group Member 4: _____

Project No. 2

Individual Hours Spent on Project

Leading Hours (Hours working independently or leading cooperative work.)

Group Member	Organize	Train	Site Visit	Drafting	Write-up	QA / QC
1	0	0	0	0	3.5	0
2	0.5	0	0	5	0.5	1.5
3	0	0	0	0	2.5	0
4	0	0	0	1	1.5	0

Supporting Hours (Hours working cooperatively in a support role.)

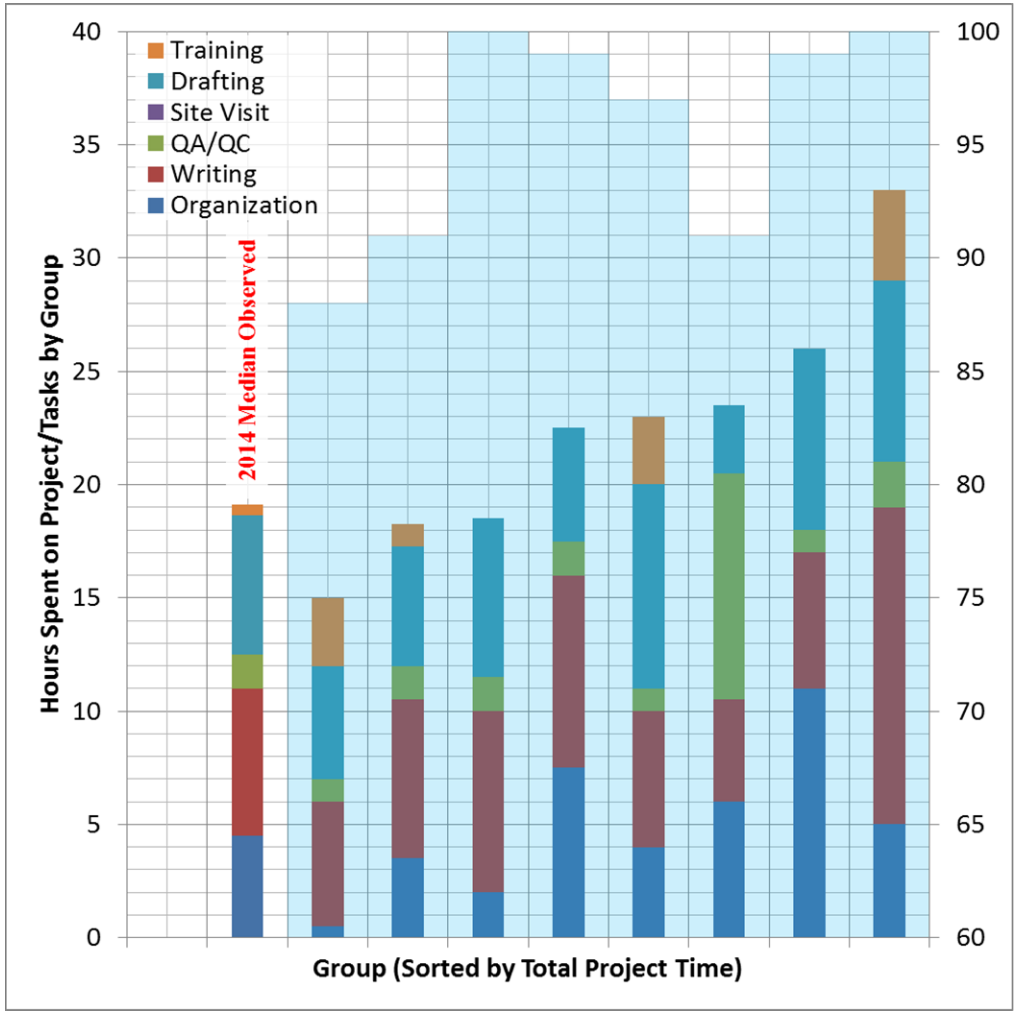
Group Member	Organize	Train	Site Visit	Drafting	Write-up	QA / QC
1	0.5	0	0	0	0	0
2	0	0	0	0	0	0
3	0.5	0	0	0	0	0
4	0.5	0	0	1	0	0

Group Hours Spent on Project

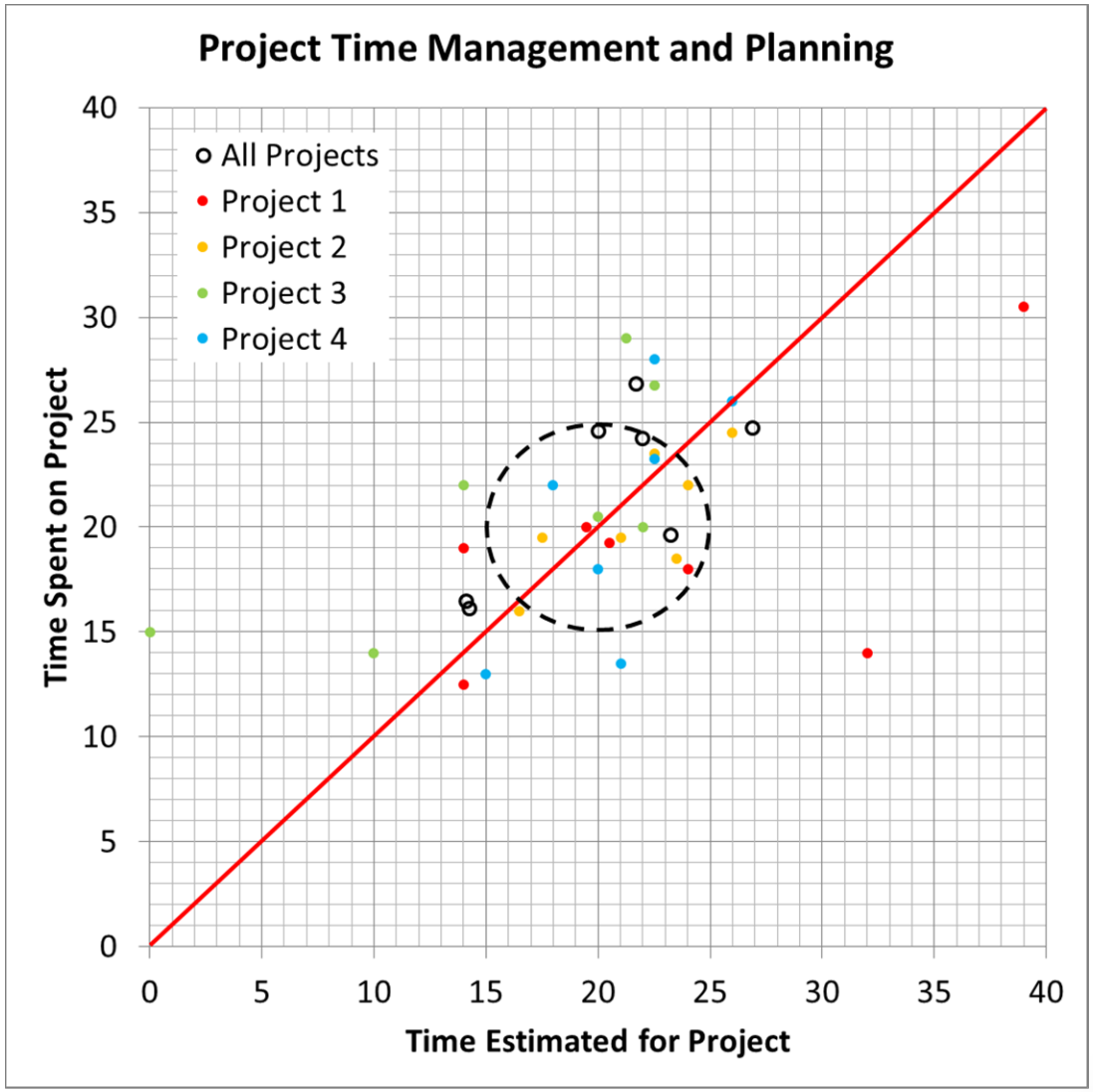
Organizing	0.5 hrs leading	Training	0 hrs leading
	1.5 hrs supporting		0 hrs supporting
Site Visit	0 hrs leading	Drafting	6 hrs leading
	0 hrs supporting		1 hrs supporting
Write-up	8 hrs leading	QA / QC	1.5 hrs leading
	0 hrs supporting		0 hrs supporting

Total 16 hrs leading 2.5 hrs supporting

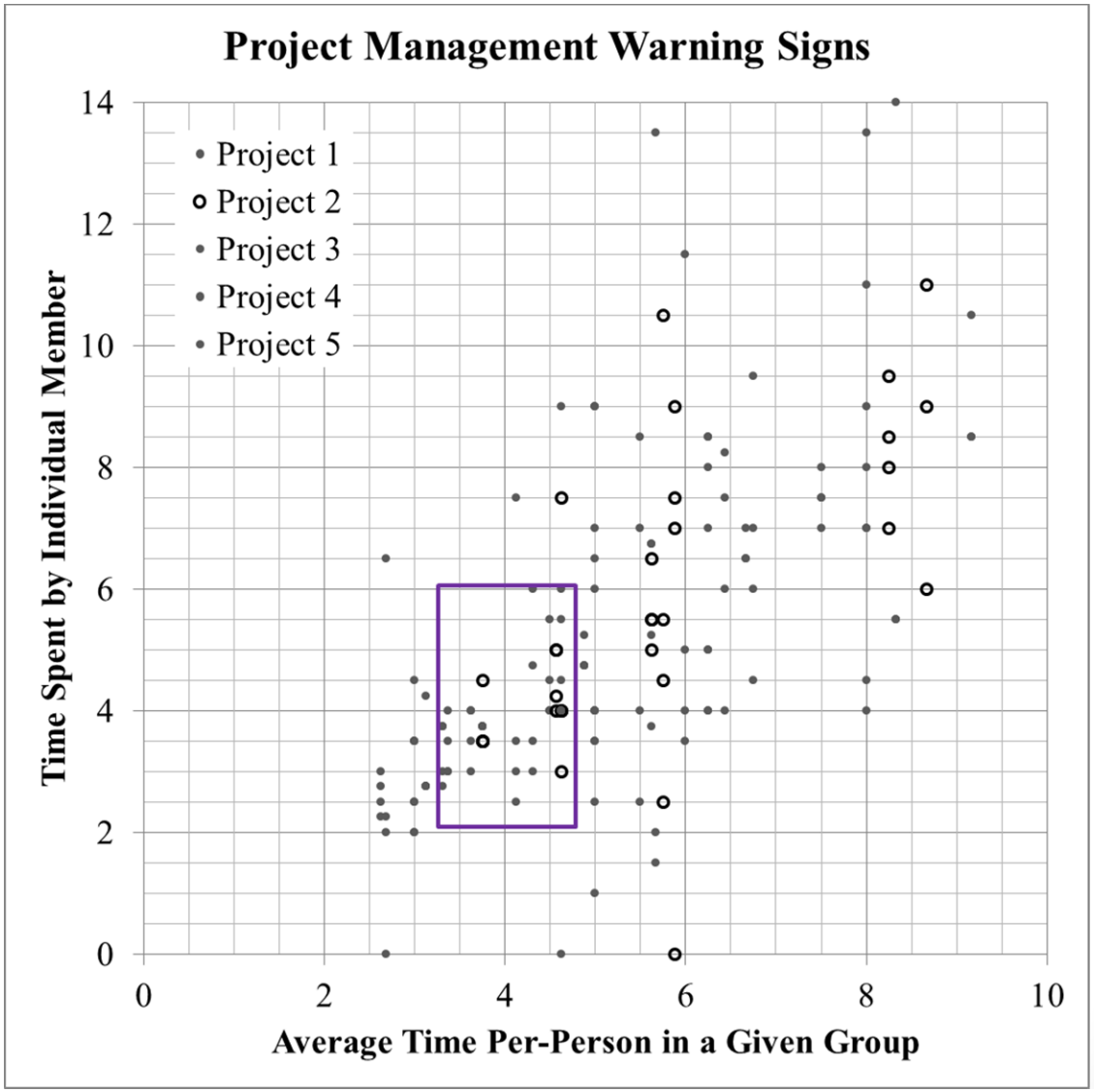
Case Study
Management – Formative Feedback



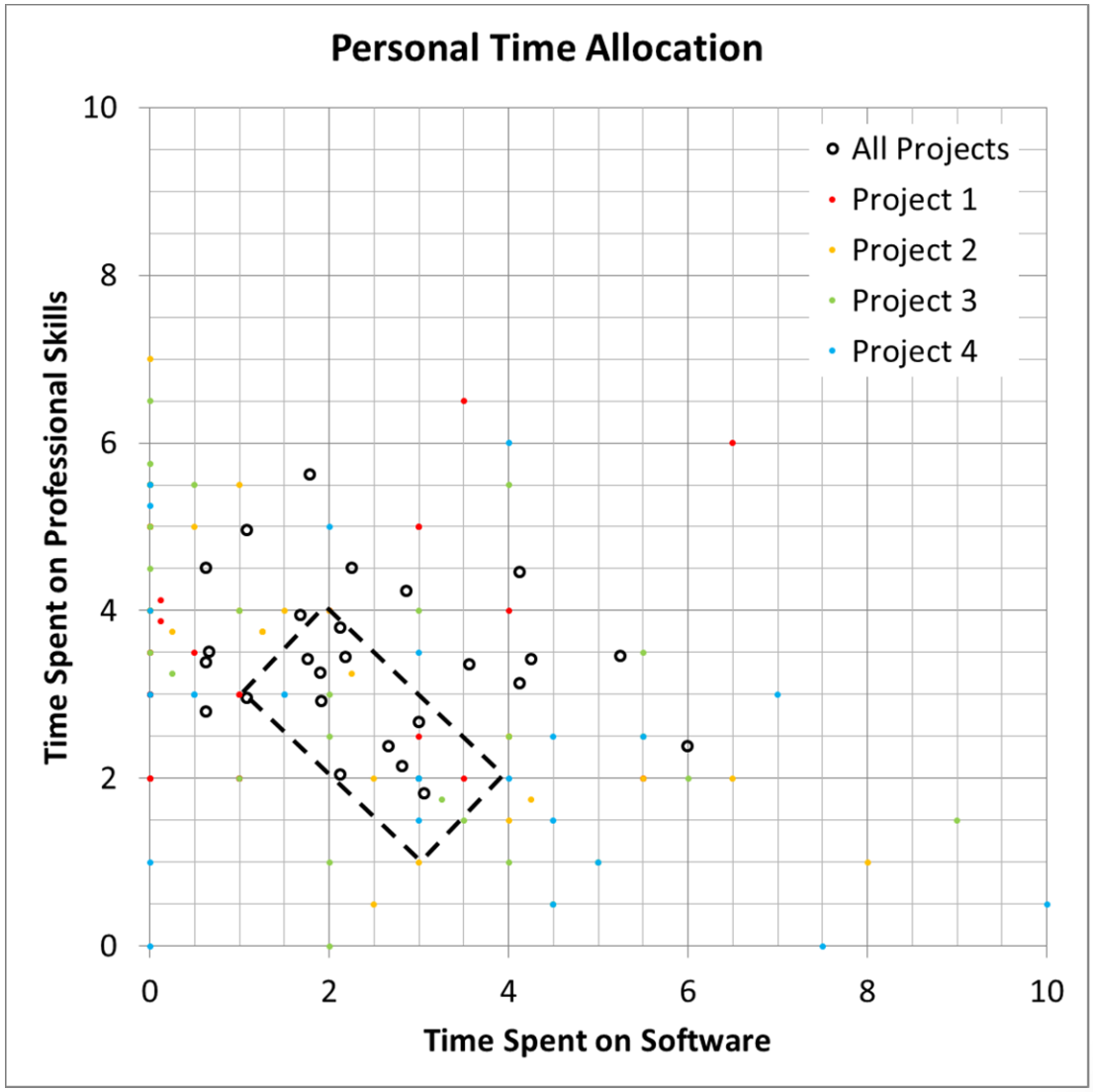
Case Study
Outcomes – Calibration Needed



Case Study
Outcomes – Calibration Needed



Case Study
Outcomes – Calibration Needed



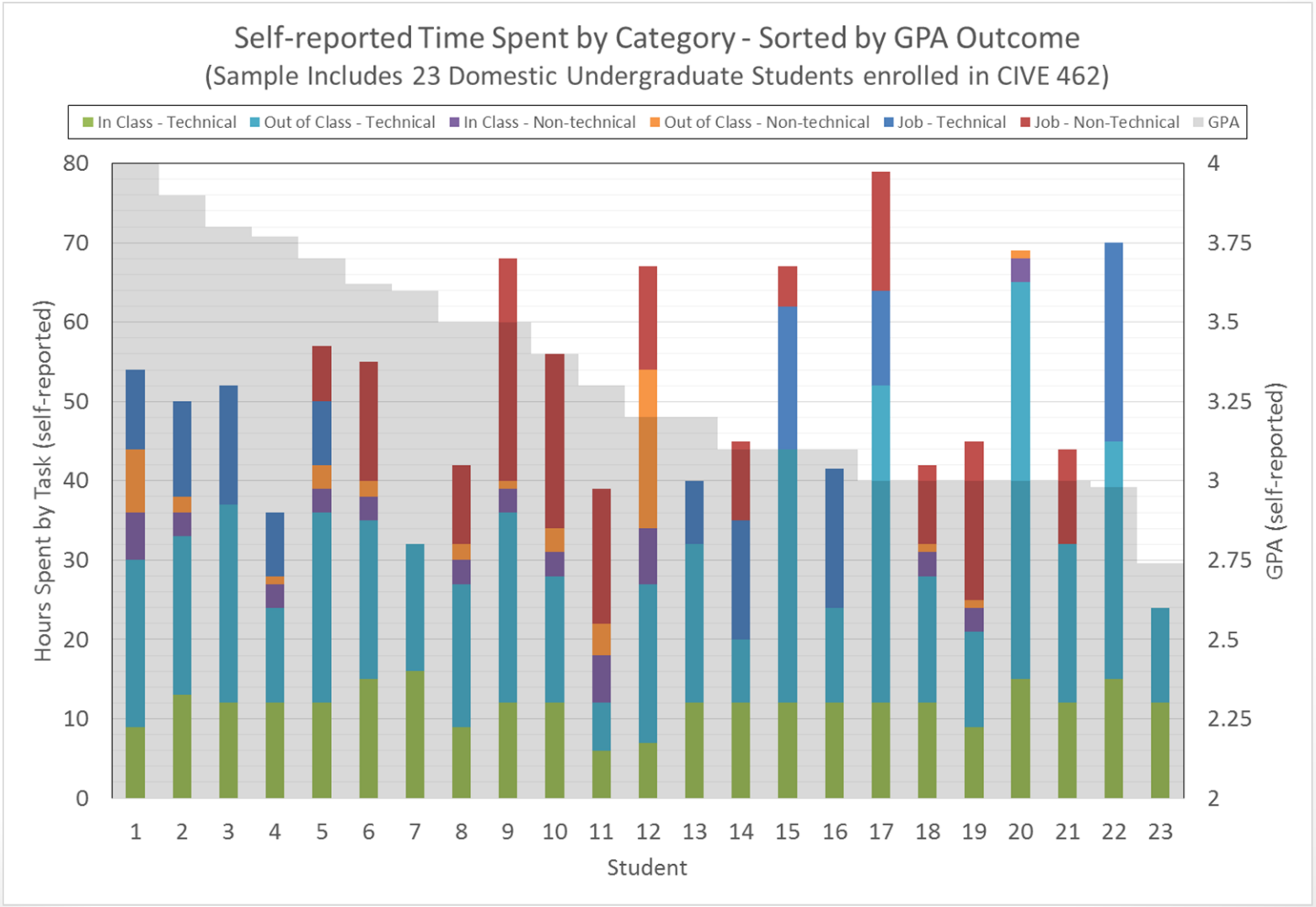
Case Study
Issues on the Table

- This data has thus far been utilized for formative feedback within the classroom setting.
  - It is time consuming, and provides good results, but the return on investment is questionable.

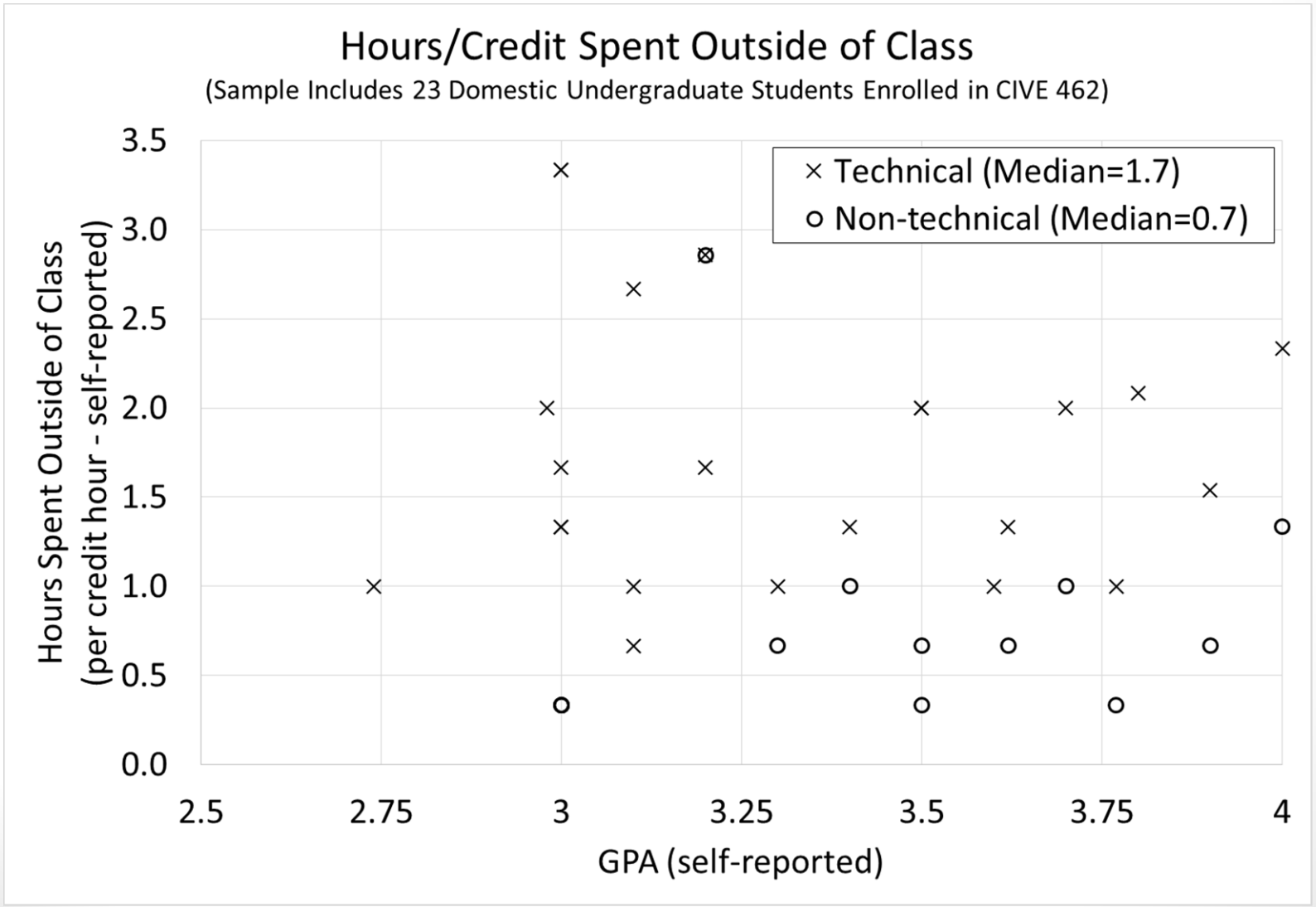
- How to leverage this information to generate papers and proposals?

- If not publishing pre-tenure, how can future data needs be anticipated so that post-tenure publications can incorporate multiple years of data?

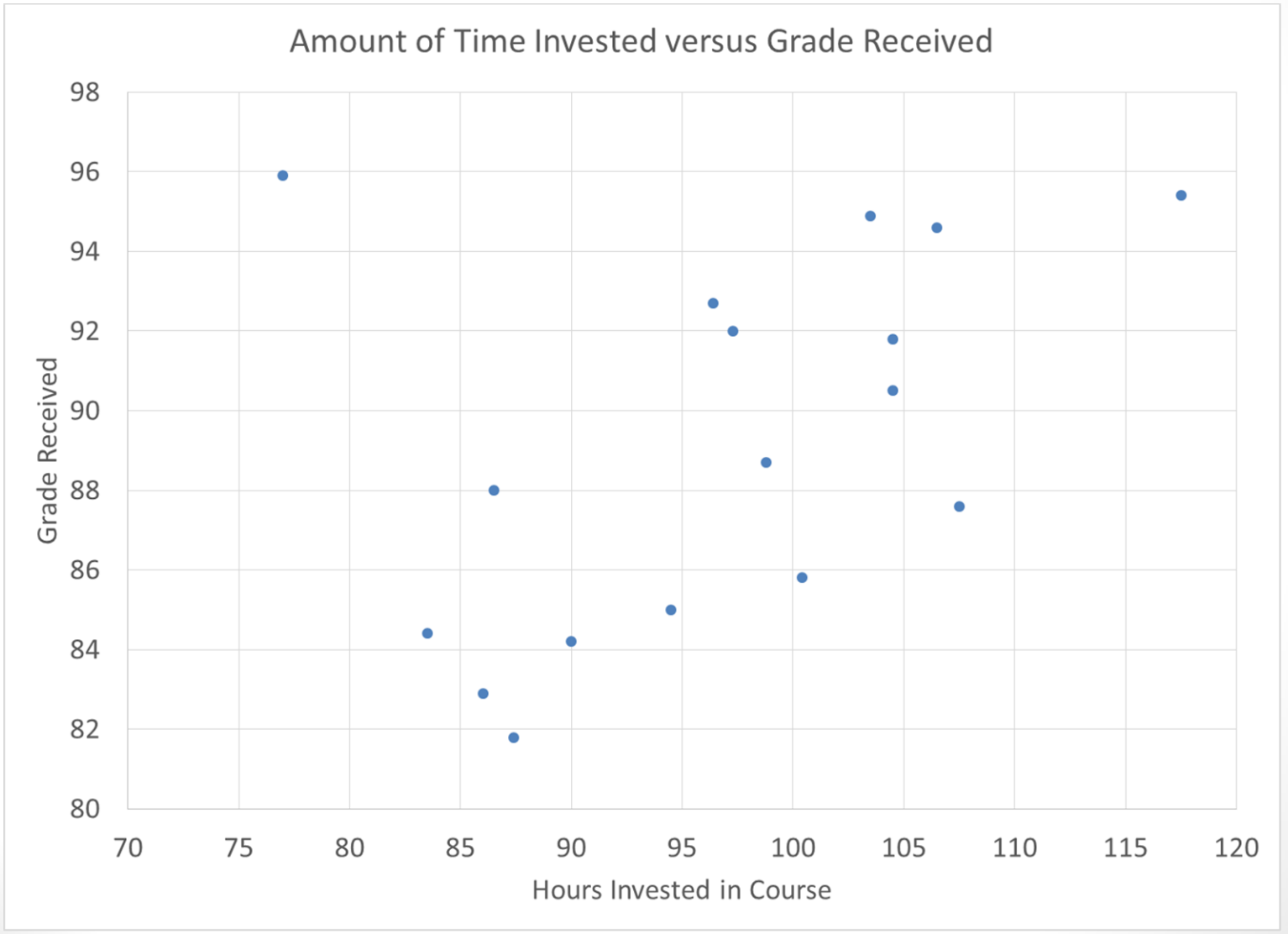
Classroom Management Random Data Results



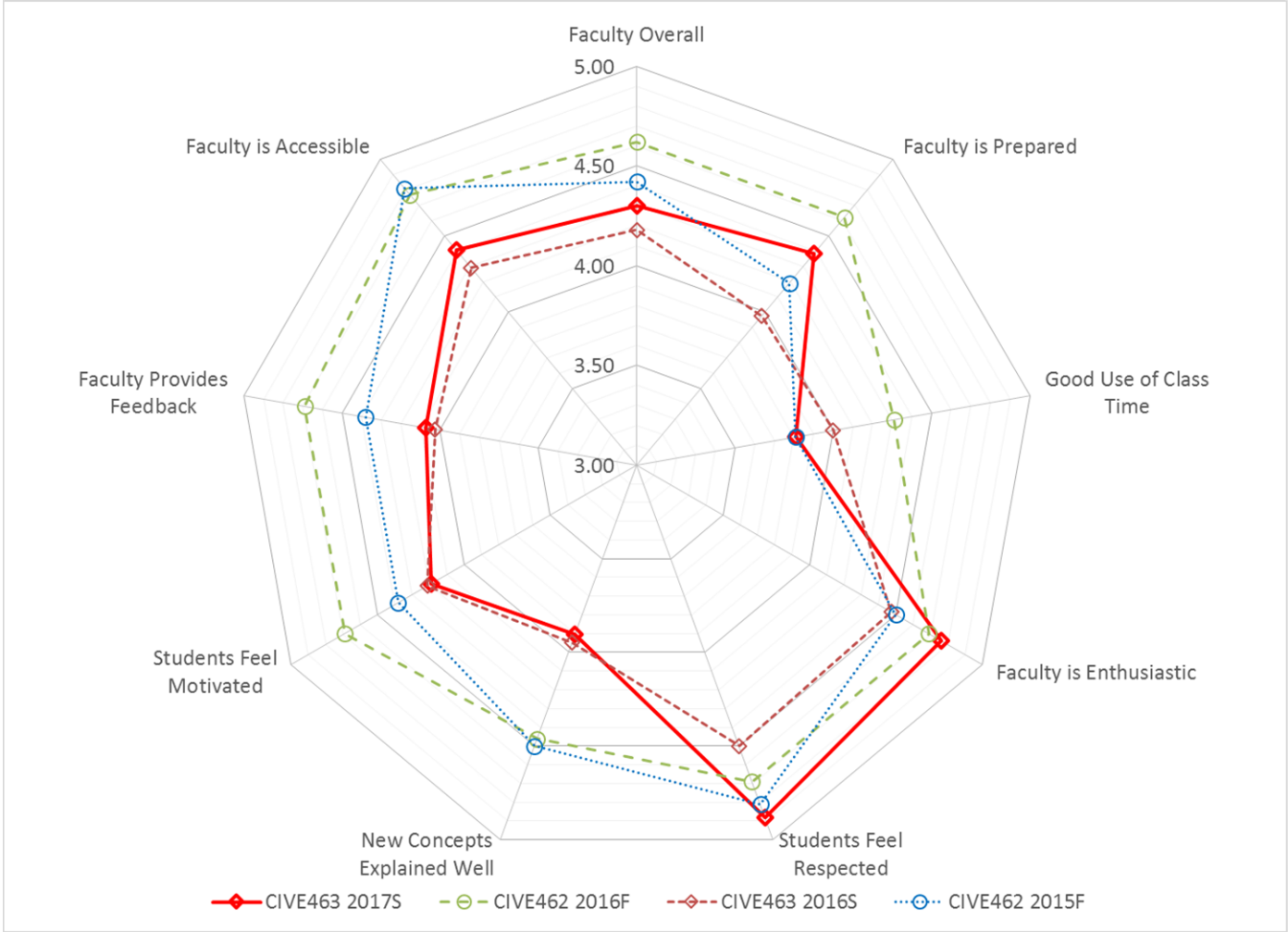
Classroom Management Random Data Results



Classroom Management Random Data Results



Classroom Management Random Data Results



Next Steps
Leveraging Content Mastery

- Draft syllabus prepared for: Foundations of Engineering Pedagogy
- Topics include:
  - History of Engineering Education
  - Motivation in Education
  - Learning Theories
  - Active Learning Strategies
  - Learning Styles, Individual Cognitive Development
  - Problem and Project Based Learning
  - Learning in Groups and Communities
  - Assessing Learning
  - Technology and Learning
  - Engineering Design
  - Freshmen to Seniors, and Everything In-between
  - Improvement in Engineering Education (and Barriers)

Next Steps

Formalizing Group Management Architecture

- Potential to formalize the group management work that I've done in a number of formats.
  - Projects are based on specific site, but with (a fair amount of) work could be generalized for any site.

- Formal lab book with the step-wise instructions.
- Applied textbook on the topic of the course, featuring a template for extensive project work in the class.
- Conference publications on outcomes from the methodology.

- None of this seems right for pre-tenure pursuit.

Next Steps
Leverage other classroom innovations

- Potential to leverage the “talking points” method I use for classroom active/passive engagement.
- Daily handout with a series of questions tied back to lecture slides that go beyond the content and seek the “why is this important” or “how is this applied in the real world” type knowledge.

- Reminds me to pause periodically during lecture.
- Lets students know that some interaction is expected every few slides.
- Gives students opportunity to anticipate question, and compose response ahead of time.

Next Steps
Leverage other classroom innovations

- Talking Points applications:
- Potential funding proposal to study impacts of passive classroom engagement.
- Examine contributing factors to learning outcomes of class:
  - Level of engagement with written (un-graded) handout.
  - Level of engagement with verbal communication.
  - Stated intention for engagement with course.
  - Standardized test scores.
  - Overall GPA coming into the class.
  - Etc.

Questions? Collaboration? Contact any time!

- John Sangster, Ph.D., PE, PTOE
- Assistant Professor, Department of Civil Engineering
- University of Nebraska at Lincoln
- John.Sangster@unl.edu